I-295 CRCP PERFORMANCE UPDATES

Dr. Mohamed Elfino, PE
Dr. Celik Ozyildirim, PE
Dr. Harikrishnan Nair

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OUTLINE

• Background
• Objective
• Distress Identification/ Failure Mechanisms
• Remedial Actions
• Materials
• Design
• Construction
• Conclusions
• The first Continuously Reinforced Concrete Pavement (CRCP) built by the Virginia Department of Transportation (VDOT) was in late 1960’s on I-64 around Richmond. Typically, 8 or 9 inches thick, Using transverse steel and Chairs.

• CRCP on I-64 New kent County (1971) used feed Tube system without transverse steel or chairs.

• Subsequently, no assurance that the longitudinal steel position was at mid-depth.

• 1973 and beyond, Cement production led to high Alkalinity.

• Subsequently, ASR phenomenon was born.
Background

• I-295 is 53 miles CRCP corridor with three pavement designs.
• Section A, 25 miles long. Starts from North of Route 60 (MM28). 8” CRCP, 6” CTA on top of subgrade, Asphalt shoulder, No edgedrain. Completed 1979.
• Section B, 23 Miles long, Starts from South of Route 60 (MM28) 9” CRCP, 8” CTA on top of subgrade, Tied Concrete shoulder, and edgedrain.
• Section C, 5 miles long, at the southern end of the corridor. 9” CRCP, 4“ Cement Treated OGD, 8” CTA on top of subgrade, tied concrete shoulder, and edgedrain. Completed in the late 1990’s.
• All sections were designed for 20 years, using PCA Method
VDOT Objective

Place High-Performance Concrete (HPC) Pavements that are:

- Durable
- Safe
- Economical
FEED TUBE SYSTEM
DISTRESS IDENTIFICATION/ FAILURE MECHANISMS

Distress identification was based on extensive field forensic investigations and consistent concrete pavement condition surveys.

DISTRESS IDENTIFICATION

• Edge Punch-outs
• Localized Areas of Broken Concrete
• High Steel
• Horizontal Delamination
• Broken concrete at the header
• Map Cracking/ASR
• Longitudinal Cracking
• Pavement approach slabs failures
• Sags
EDGE PUNCH-OUT
PUNCH-OUT IN THE PRESENCE OF CLOSELY SPACED CRACKS
Y SHAPE CRACK
DUE TO LACK OF CONSOLIDATION
LOCALIZED BROKEN CRCP
HIGH STEEL CAUSED BY FEED TUBE INSTALLATION
SEPARATION DUE TO DELAMINATION
SLAB ACTS AS TWO THINNER SLABS
Broken Concrete Attributable to Delamination and Loading
Header Construction
EVIDENCE OF LACK OF CONSOLIDATION AT THE HEADER
ASR close up
VDOT’S APPROACH TO ELIMINATE ASR

• Limit max. alkali content to 0.45%

• For higher alkali contents
  – Use Class F fly ash or slag or SF in different minimum amounts depending on alkali content
  – Test concrete by ASTM C-441 -- Max. 56 day expansion is 0.10%
LONGITUDINAL CRACKING
Potential Longitudinal Crack
Due to uneven spreading of Concrete
Cracked JPCP Before Bridge approach
Mid-slab Cracking of JPCP Approach Slabs
Faulting between the JPCP and bridge Approach
Using Borescope to Quantify the Size of Void Under Approach Slabs
SAGS OR DEPRESSIONS
Dealing with sags at the bridge approaches

• Modified the requirements for constructing the backfill behind the backwall of bridges.

• Depth of select material used behind the footing increased.

• Minimum compacted dry density increased.
Changing the plain jointed approach slabs to a single reinforced slab.
• On Madison Heights CRCP project, trial section was used to ensure that paving and materials will result in acceptable product.
Aggregate Maximum Size and Grading
Use of 50 mm NMSA
Use of uniform grading (well graded) enabling use of large amount of aggregate
Minimizing paste content

Pozzolans/Mineral Admixtures
Since early 1990s, VDOT has been requiring pozzolans (Class F fly ash) and slag to inhibit ASR if the alkali content of cement is high (currently 0.45% is the limit).

Strength Tests
(correlation between flexural strength and compressive strength), Shrinkage tests, Maturity
# SIEVE ANALYSIS FOR ASPHALT OGDL

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A.C. pg 70-22 Content: 4.3 ± 0.3%

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Particle Size Distribution for Asphalt OGDL

Asphalt Treated OGDL Gradation

- Min
- Max
- Average

Percent Passing vs. Particle Diameter (mm)
STEEL CHAIR RESTING ON ASPHALT TREATED ODGL
Using transverse steel spaced at 1.2 m (4 ft) to support the longitudinal steel and to keep the longitudinal cracks tight in the event of their occurrence.

Use of an asphalt layer 75 mm (3 in) thick that provides stability and drainability under the slab.

Modifying Edgedrain standards & performing video inspection to ensure effective drainage during pavement service life.

Modified the requirements for constructing the backfill behind the backwall of bridges.
Use of a wider travel lane of 4.3 m (14 ft) while keeping the delineating white line at 3.6 m (12 ft).

Use of thicker slab to reduce the high shear stress at the level of steel.

Increasing the amount of reinforcing steel from 0.65% to 0.70% to improve the crack spacing.
I-64 Battlefield Blvd. Reinforcement
Steel in place
#7 Longitudinal Steel Bars
(0.7% Steel)

Minor sinkage at steel overlap
• CMAA Innovation Award
• **Battlefield Boulevard Project Does It Again**
• The Construction Management Association of America is the latest group to present the Battlefield Boulevard project in the Hampton Roads District with an award for innovation. This $100 million project located in Chesapeake consisted of interstate and overpass widening and interchange reconstruction. It saved money, conserved materials, reduced waste and increased work zone safety by including the following innovations:
  • Braided ramps
  • Constructing a concrete batch plant in the median to eliminate trucks from entering and exiting the work zone
  • Reusing existing concrete pavement for roadway base material
• The project team has also won awards from *Road and Bridges Magazine*, Hermes Creative Awards, the Communicator Awards, Public Affairs Society of America Pinnacle Awards and the American Consulting Engineers Council.
CONCLUSIONS

1. Use an analytical approach and benefit from the lessons learned to extend the service life of CRCP with minimal maintenance.

2. Use consistent pavement condition surveys that aid VDOT in identifying critical distresses and good performing pavements.

3. Establish the failure mechanism for each distress before starting pavement rehabilitation or making any changes to improve CRCP performance.

4. Reach the most logical failure mechanism by understanding pavement design, concrete mix design, the factors affecting concrete production, the interaction between the concrete components and environmental conditions, and construction practices.
5. Adopt and implement changes to improve CRCP.

6. Monitor and provide feedback to measure the effectiveness of the changes made.

7. Establish cooperation among pavement design engineers, materials engineers, researchers, and the industry to implement changes.

8. Utilize pre-paving conferences to establish VDOT expectations and sharing lessons learned.
THANK YOU